Lifter
User Guide

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intelligent motion gmbh
Hauptstrasse 13
4552 Wartberg a.d. Krems
Austria

Website: www.intelligentmotion.at
E-mail: info@intelligentmotion.at

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For reasons of improved readability, gender-specific references (male/female/other) are not made in these instructions. All statements apply in equal measure to all genders.

1. General information

Introduction

Dear Customer,

This user guide is intended to show you what is possible with the lifter and will help you to use and integrate the apparatus into your training programme.

You have opted for an exercise machine that was designed with the highest requirements in terms of technology, safety, optimal functionality and ergonomics.

The lifter has many different training and analysis options, and it is therefore important for the athlete to be familiar with the different training techniques available to them. Certain training methods that are possible with the lifter cannot be undertaken on standard fitness equipment. These methods have been thoroughly researched and can have outstanding effects on an athlete’s performance, structural and functional body components.

Using the lifter, it is possible to train with either a free barbell or captive barbell. Free weights are highly versatile and allow a wide range of multi-joint exercises, which in turn enable time-efficient training sessions. However, free weights can be intimidating for beginners and carry a high risk of injury if the selected weight is too heavy. The lifter can be used with heavy loads to deliver an extremely high degree of safety. Training to the point of volitional muscle failure can also take place safely, without the need for a spotter and with no risk of injury. Furthermore, barbells can be used regardless of body type, while other machines may not be well suited for certain body types. Here too, the lifter can be adjusted and used on an individual basis. The captive barbell is ideal for such activities as eccentric training or isometric strength measurements.

The lifter is a piece of automated apparatus. You should therefore take particular note of the safety rules and instructions provided in this user manual. Before delivery, all exercise machines are tested to ensure safe operation.

Please read the following pages carefully, as the methods can be very demanding on the athlete's body. The athlete must warm up thoroughly and specifically for the intended activity before any use of the lifter.

We hope you enjoy great success with the lifter!

Yours, intelligent motion gmbh

Technical specifications

Voltage	3~ AC 400 V (+/- 10%)
Power consumption	7 kW
Max. weight when training with a free barbell	400 kg
Max. Total weight when training with a captive barbell	6000 N
Net weight	970 kg
Speed	0.01 – 2 m/s
Max. Acceleration	4 m/s^2

2. Training with free barbell

If exercise with a "free barbell" is selected, the athlete trains exclusively with the free, non-captive barbell. During training, the lifter is able to follow the movement of the barbell with the support arms and in doing so keep it secure.
It is essential that the barbell is connected to the sensor cords.

Training with a free barbell triggers more muscle activity than with a machine. For example, squats with free weights result in 43% higher EMG activity than squats with a machine.[1]

In this training format, different exercises can be performed as follows:

Eccentric training

Eccentric training is attracting increasing interest. During the eccentric movement, the muscle lengthens while generating force at the same time. Because a greater volume of training can be performed beyond muscle growth with less metabolic and cardiorespiratory expenditure, eccentric muscle work represents a promising training strategy – not only for improving the athlete's performance, but also for maintaining or restoring physical performance and quality of life.[2]

[1] See Schwanbeck, Chilibeck and Binsted, 2009
[2] See Hody, Croisier, Bury, Rogister, Leprince, 2019

Eccentric training is particularly suitable for:[3]

- Increasing muscle strength
- Stimulating greater muscle growth
- Desensitising the CNS
- Improved jumping abilities
- Preventing injuries
- Improving rehabilitation

Given that eccentric training can lead to high levels of muscle damage and the CNS is put under a great deal of strain, eccentric training sessions should be limited to 1-4 times a week depending on the training and rehabilitation goal, and rest periods of 24-72 hours should be observed.[4]

Execution:

The athlete allows the lifter to perform the concentric phase; as soon as the lifter has assumed its position, the athlete can remove the barbell from the arms of the apparatus and perform the eccentric phase of the movement.

Concentric training

The lifter is also able to leave the only concentric part of the movement to the athlete, and perform the rest of the movement.

Concentric movement is the shortening of the muscle while it contracts at the same time. For example, standing up from a squat or pushing up the barbell.

Execution:

The athlete performs the concentric phase of the movement with the barbell and then transfers the barbell to the lifter, which continues the movement back to the original starting position.

[3] See Patterson and Raschner, 2020
[4] See Hody, et al., 2019

Spotter mode

In spotter mode, the lifter arms follow the barbell during the movement performed at an individually adjustable distance from the arms of the apparatus. As soon as the athlete wants to stop the movement, the trainer can stop the apparatus arms at any time and in any position, at which point they intercept the weight.

Potential injuries and unnecessary strain on the body are no longer an issue when the athlete attempts to lift heavy weights.

Performing the exercises with the free barbell on the display:

Exercise selection "Supported" > Select support type and speed > Set movement limits > Select exercise mode > Optionally move to start position > Start

Jump

The ability to generate high forces and power during loaded motor tasks (e.g. vertical jumps) is of crucial importance for athletic performance. To increase jumping, speed or explosive strength, athletes often perform jumping movements with additional weight in the form of a barbell on their shoulders. [5]

Without the support of the lifter, the additional weight would be limited by the fact that the athlete must absorb this weight upon landing after performing the jump. The lifter supports athletes in this exercise by following the bar upwards with its arms during the jump and intercepting it at the highest point. This means that the athlete does not have to absorb the weight themselves upon landing.

There are two ways to execute the jump. To perform the exercise, select the appropriate training mode:

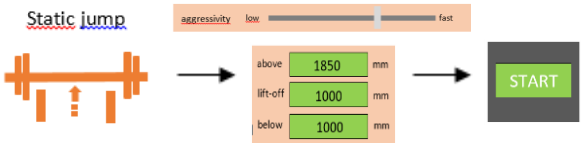
Static jump

The athlete lifts the bar, starting the exercise. The arms of the lifter move down automatically to the configured jump position. Once in position, the arms come to a stop. The apparatus waits until the barbell has reached the bottom configured limit. The athlete performs the downward movement until the bar is within this range; it can also be placed on the arms. A beep signals that the lifter is ready to follow the barbell upwards.

Jump: The athlete jumps upwards with the barbell – the arms of the apparatus move at maximum speed (approx. 2.5 m/s) and intercept the barbell again at the reversal point.

[5] See Kang, 2018

Execution on the display:



Exercise selection "Static jump" > Enter positions > Select movement dynamics > Start

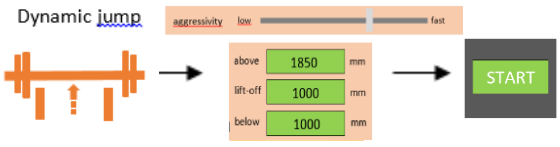
Dynamic jump

The athlete lifts the bar, starting the exercise. The arms of the lifter move down automatically to the configured jump position. Once in position, the arms come to a stop. The athlete starts the downward movement. As soon as the athlete performs an upward movement with the barbell, the apparatus arms begin to move upwards, maintaining a defined distance between the barbell and the arms. The direction of movement is exclusively upwards.

Jump: The athlete jumps upwards with the barbell – the arms of the apparatus track the motion and intercept the barbell again at the reversal point.

Examples of other forms of movement with this function include the Bench Press Throw and Split Squat Jumps with additional weight.

Execution on the display:



Exercise selection “Dynamic jump" > Enter positions > Select movement dynamics > Start

Supportive training methods

The lifter can be used to support the following training methods.

Exercise recommendations are typically proposed along the so-called "repetition continuum". The repetition continuum assumes that the number of repetitions performed at a certain weight leads to specific changes as follows:[6]

- A moderate repetition pattern with moderate weights (from 5 to 15 repetitions per set with >30% of the 1-repetition maximum (1RM)) optimises hypertrophic gains.
- A pattern with low repetitions and heavy weights (from 1 to 5 repetitions per set with 80% to 100% of the 1RM) optimises strength gains.
- A pattern with a high number of repetitions and light weights (more than 15 repetitions per set with loads below 60% of the 1RM) optimises local improvements in muscle endurance.[7]

Hypertrophy training

Muscle hypertrophy is the growth of muscle tissue, which can manifest itself in a variety of ultra-structural adaptations. The mid-range of the repetition continuum is generally referred to as the "hypertrophy zone"[8].

The most crucial aspect of hypertrophy training is the use of regular progressive and exhaustive exercise stimuli that activate at least one mechanism of action responsible for hypertrophic effects.[9]

Taking into account the entire scope of literature, the following evidence-based conclusions can be drawn that similar overall muscle growth (i.e. muscle cross-sectional area, CSA) can be achieved over a wide range of load ranges ≥ ~30% of the 1RM. These findings are independent of age and training status. From a practical perspective, it can be argued that moderate weights are the most efficient means of muscle development, because training with low weights requires many more repetitions compared to using heavier weights, which in turn increases training time.[10] The number of repetitions should

[6] See Haff and Triplett, 2015
[7] See Schoenfeld, Grgic, Van Every, Plotkin, 2021
[8] See Haff and Triplett, 2015
[9] See Gavanda and Isenmann, 2021
[10] See Schoenfeld et al., 2021

therefore be between 6 and 15 and the rest time between sets should be >60 seconds. Up to 3 - 4 training sessions per week per muscle group are recommended.[11,12]

Execution:

In hypertrophy mode, the athlete performs the repetitions with the applied weight as in normal barbell training. As soon as the athlete fails to complete another repetition, the trainer stops the lifter, which then intercepts the barbell.

➔ 6 - 15 reps with >30% of the 1RM, 3 - 5 sets, break time of >60 s

Supplementary training methods that are suitable as very intensive and time-saving methods for ambitious athletes are described below:

Drop set training

With drop set training, the training time is reduced by minimising the breaks between sets. The strategy is to perform a traditional set, reduce the load and then immediately perform another set (or several sets). Typically, 1 - 3 drops are used with a weight reduction of 20 - 25%, with all sets being performed until the point of volitional muscle failure. A proposed rationale behind this method is that drop sets induce greater metabolic stress and possibly increased muscle damage, which in turn could exacerbate the hypertrophic response. [13]

Despite the limited evidence, drop set training appears to allow for shorter training sessions without reducing training volume or training responses (especially hypertrophy).[14]

As this method involves a great deal of muscle utilisation, the high safety factor of the moving apparatus arms is very important to prevent injuries.

Execution:

➔ 1 - 3 drops with weight reduction of 20 - 25% of the conventional set

[11] See Morton, Colenso-Semple and Phillips, 2019
[12] See Iversen, Norum, Schoenfeld, Fimland, 2021
[13] See Schoenfeld and Grigic, 2018
[14] See Iversen et al., 2021

Superset training

Superset training (also known as paired set training or compound sets) refers to performing two or more exercises in succession with limited or no rest in between. Supersets can be performed by pairing exercises for the same muscle group or by pairing exercises for different muscle groups. Performing superset exercises for the same muscle is a primarily body-building approach in which more time can be spent training individual muscles.[15]

Acute cross-over studies support the assumption that when training to volitional muscle failure with an 8-12RM loading pattern, superset training can be performed in roughly half the time of conventional training without compromising training volume. Exercises are combined in all these instances for agonist and antagonist muscles. It has been suggested that preloading antagonists may favour increased neuronal activation, which significantly increases strength performance and therefore enables a higher training volume. Further results also indicate that superset training causes higher lactate production and a higher level of fatigue than conventional strength training. This can significantly reduce training time, but at the same time also impair the neuromuscular performance and capacity for generating power during training, especially during strenuous multi-joint exercises.[16,17]

IC training

Intramuscular coordination training, or IC training for short, is a high-intensity strength training programme designed to increase maximum strength. IC training describes the ability of a muscle to contract as many of its muscle fibres as possible. The load intensity must be very high (approx. 90 - 95%) and the number of repetitions low at 1-5 repetitions. The American College of Sports Medicine (ACSM) and the National Strength and Conditioning Association (NSCA) recommend a break of 2 - 5 minutes between sets depending on the training condition and up to 3 - 4 training sessions per week per muscle group. The higher the load, the lower the number of repetitions and sets.[18,19]

Execution:

- ➔ 1 - 5 reps with a load of 90 - 95% of maximum strength, 5 - 8 sets with a break of 2 - 5 min.

[15] See Iversen et al., 2021
[16] See Antunes, Bezerra, Sakugawa, Dal Pupo, 2018
[17] See Maia, Willardson, Paz, Miranda, 2014
[18] See Schoenfeld et al., 2021
[19] See Iversen et al., 2021

Repetition speed

To summarise, it can be said that a wide range of repetition speeds can be used to induce muscular adaptations.[20]

A meta-analysis showed that it is unlikely that a certain repetition rate leads to greater hypertrophic gains than another, if the training is performed to the point of volitional muscle failure. It was found that repetition durations (combined concentric and eccentric) between 0.5 to 8 seconds led to similar muscle growth. However, there appears to be a speed threshold and using super slow speeds (≥ 10 s) may actually result in a poorer hypertrophic response compared to using faster speeds, probably due to sub-optimal muscle fibre stimulation. [21]

It should also be noted that there may be unique differences in the hypertrophic response between muscle groups and some muscles may benefit more from faster speeds, while other muscles may benefit more from moderate to slower speeds.[22]

[20] See Iversen, et al., 2021
[21] See Schoenfeld, Ogborn and Krieger, 2015
[22] See Hackett, Davis, Orr, Kuang, Halaki, 2018

3. Training with a captive barbell

Another option is to train with a captive barbell. The barbell supplied by intelligent motion gmbh can be held captive between the arms of the lifter. The horizontal position can be freely selected.

This allows the athlete to benefit from additional training methods such as isokinetic or isometric training.

Furthermore, another bar that is clamped in two supports (the so-called safety barbell) serves as an added safety measure. It protects the athlete – in particular when training with a bench – from lowering the captive barbell too far through the apparatus arms.

Isokinetic training

During isokinetic training, the apparatus moves its arms with the captive barbell in a fixed, pre-defined range of motion at a constant speed and acceleration that is also set in advance.

Isokinetic training, in particular with multi-joint movements, leads to an increase in maximum strength, muscle mass, strength endurance and jumping performance. The combination of isokinetic strength training and eccentric overload leads to greater muscle hypertrophy compared to conventional strength training.[23]

In contrast to conventional strength training, maximum torque can be achieved across the entire range of motion when applying isokinetic training principles, which could explain the greater training effect of this form of training.[24]

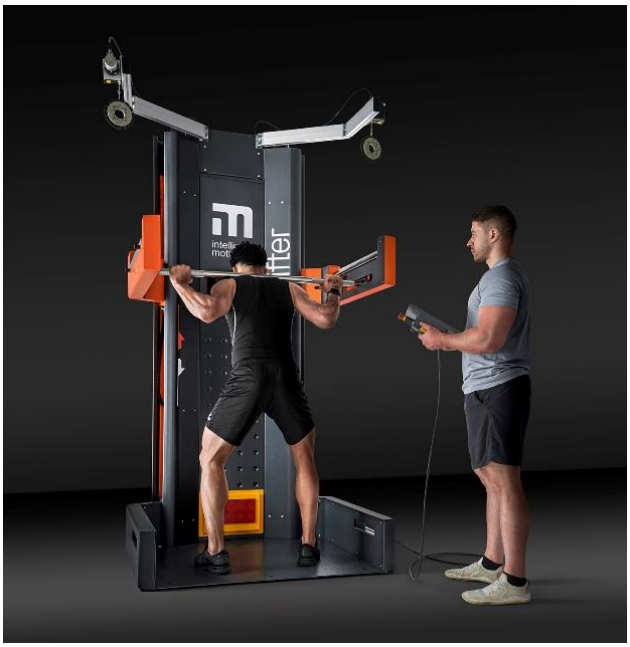
The movement boundaries are based on the entered movement limits. Speeds of between 10 mm/s and the defined maximum speed of 2000 mm/s can be specified for the automatic movement of the arms. The entered acceleration defines the "aggressiveness" of the change of direction. The strength progression of the training is then graphically shown on the apparatus display.

Execution on the display:

Exercise selection "isokinetic" > Enter limits, speed, acceleration > Select training control > Move to start position > Start

[23] See Horwath, Paulsen, Esping, Seynnes, Olsson, 2019
[24] See Golik-Peric, Drapsin, Obradovic, Drid, 2011

Isometric training



Isometric training involves sustained contraction against immovable resistance without changing the length of the muscle group concerned. Maximum isometric exercise can have a significant impact on improving strength gains and strength endurance, strengthening the stabilising muscles as well as the deep muscles, but also on parameters such as reducing high blood pressure.[25] During the isometric measurement, the lifter holds the set position of the barbell and the force exerted by the athlete against the barbell is statically measured.

Execution:

The apparatus is moved to any position and the athlete assumes a position below the captive barbell. The axes remain switched on. As soon as the exercise is started, time recording begins and the athlete applies maximum force against the barbell.

The strength progression of the training is then shown graphically on the apparatus display by means of a strength-time curve.

In this way it is not only possible to quantify the strength values, the athlete can also receive direct feedback in order to achieve the target even more specifically.

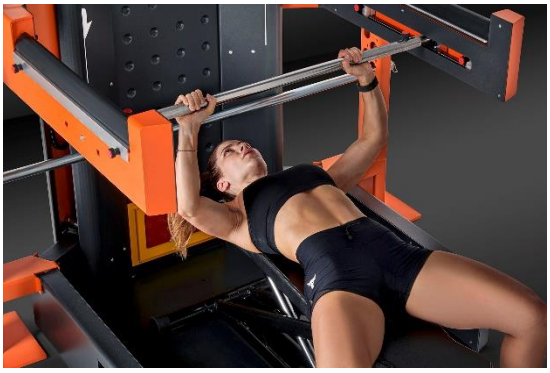
The following parameters are evaluated:

- Maximum force
- Explosive force (RFD)
- Force surge
- Starting force
- Dynamic strength index (DSI)

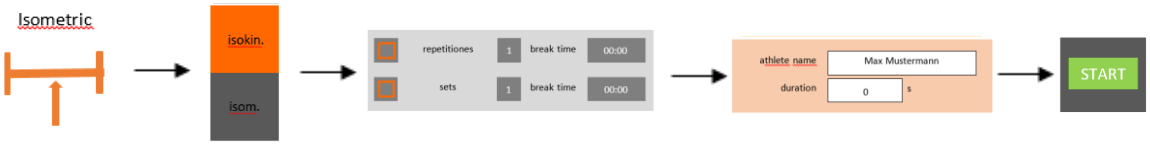
[25] See Baffour-Awuah, Pearson, Dieberg, Smart, 2023

The following forms of exercise can be carried out, for example:

- Isometric training in different knee angle positions
- Isometric bench press
- Isometric overhead press
- Isometric split squats



Execution on the display:



Exercise selection "isometric" > Move to positions > Enter duration, repetitions, sets, pause time > Duration [s], optionally enter athlete name > Start > Beep sounds at start and stop

Training with a captive dumbell

In addition to the normal captive barbell, there is also a dumbell for clamping into the apparatus arms. Further to the fixed barbell exercises, this enables a greater range of movement and an exact distribution of the lateral force exerted.

4. Analysis

Isometric force measurement

Because the lifter has integrated load cells in its arms, very precise force measurement is possible. In this way it is not only possible to quantify the strength values, the athlete can also receive direct feedback from the trainer in order to achieve the target even more specifically.

Targets:

- Determination of single-leg and double-leg strength parameters
- For classification or tracking of performance development
- As guide values for strength training control
- As a prerequisite for muscle performance (e.g. jumping performance)

Method

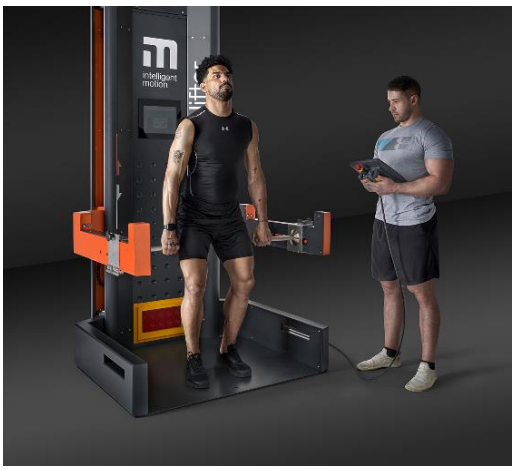
In principle, measurements can be taken in one or more joint angles on both legs or on one leg. Depending on the situation, a combination of the various options may make sense. The exact angles are not specified here, but must be defined precisely and meaningfully (e.g. on a sport-specific basis).[26]

Execution:

The apparatus is moved to any position and the athlete assumes a position below the captive barbell (standard barbell or dumbell). The axes remain switched on. As soon as the exercise starts, time recording begins and the athlete applies maximum force against the barbell. The time interval can be set up to a maximum of 5 seconds. The start and end of the time period are specified by means of an acoustic signal.

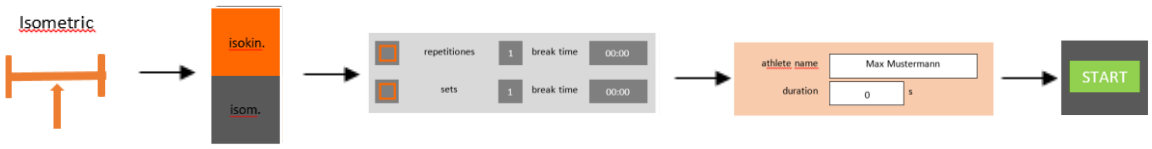
The following forms of exercise can be carried out, for example:

- Different knee bending positions
- Bench press
- Isometric Mid-Thigh Pull (IMTP)
- Isometric overhead press
- Isometric Split-Squat (ISO)



[26] See Federal Office of Sport BASPO, Swiss Federal Institute of Sport Magglingen SFISM and Competitive Sports Department, 2016

Execution on the display:



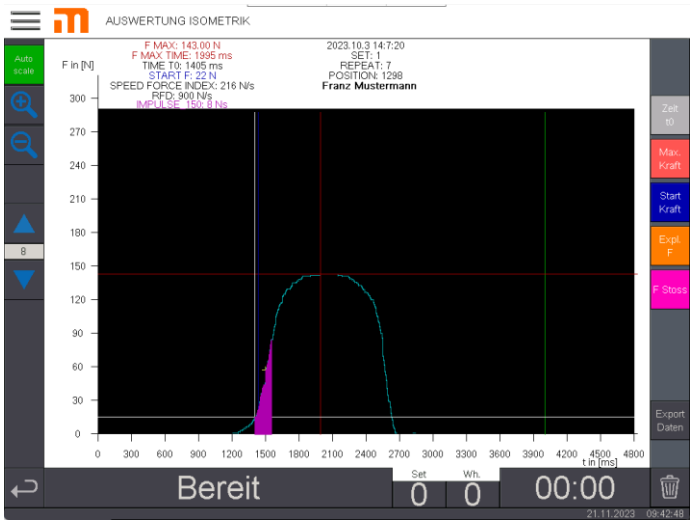
Exercise selection "isometric" > Move to positions > Enter duration, repetitions, sets, pause time > Duration [s], optionally enter athlete name > Start > Beep sounds at start and stop

Evaluation

The strength progression of the training and the calculated parameters are graphically shown on the apparatus display. The calculated data and raw data can then be exported.

The following force parameters are calculated and shown on the apparatus display after the movement:[27]

- Maximum force: The maximum force is the highest possible force that can be exerted against an insurmountable resistance.
- Explosive force: Explosive force refers to the ability to develop the steepest and fastest possible increase in force. Explosive force is defined as the ability of the neuromuscular system to further develop an already started increase in force as quickly as possible.
- Force surge:
- Starting force: The starting force is defined as the ability of the neuromuscular system to develop the greatest possible increase in force at the beginning of a contraction.
- Dynamic strength index: The DSI looks at the entire development of strength up to the strength maximum.



[27] See Bührle, Schmidtbleicher, Ressel, 1983

Jump analysis

Jumping power is a performance-determining factor in many sports. Jumping power diagnostics are used to describe the development of jumping power and to monitor performance or training.

Targets:

- Determine the explosive strength of the lower extremities in various types of jump
- Recognise signs of possible weak points (muscle-mechanical, neuronal or structural mechanisms).
- For classification or tracking of performance development

Method

In order to achieve optimum test results, the athlete must be prepared to perform to their full potential. As such, a full-body warm-up (lasting 10-15 minutes) is followed by specific activation of the muscles involved with some explosive stretching jumps or hopping exercises. A few short dynamic stretching exercises may also be part of the immediate preparation[28]

Execution:

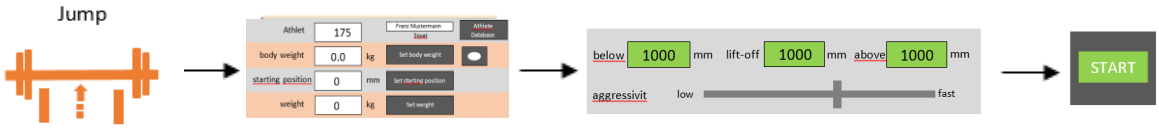
A distinction can be made between different types of jump:

- Elastodynamic: With this type of jump, the athlete performs a dynamic countermovement with both legs, i.e. by squatting to pre-stretch the muscular-tendon system immediately before performing an upward movement leading to take-off An elastodynamic jump has an eccentric and a concentric phase. The aim must be to slow down the squatting motion as much as possible, in order to achieve a short reversal point. The change in direction of movement should be very direct and should not have a long amortisation phase (unless the sport-specific movement allows this). For example: Countermovement jumps.

[28] See Werstein, Lund, 2012

- Statodynamic: The athlete executes this type of jump purely concentrically, i.e. without an elastic countermovement from the squat position. For example: Squat jumps.[29]

Execution on the display:



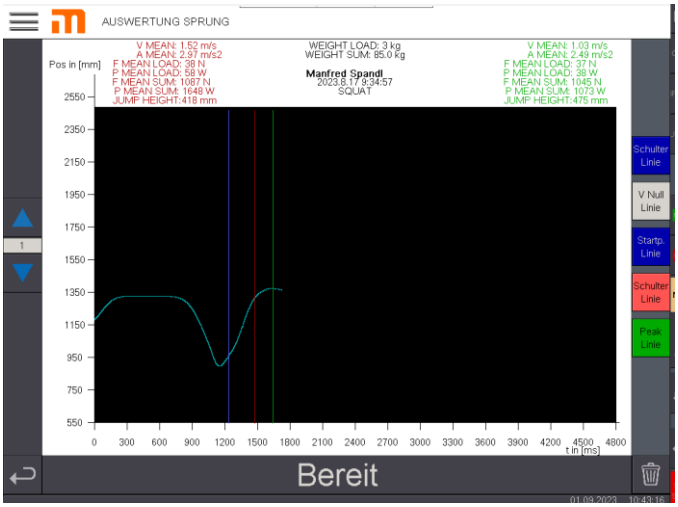
Exercise selection "Jump" > Enter calculation data and movement range > Set movement dynamics > Start

Evaluation

The jump progression and the calculated parameters are then shown graphically on the apparatus display. The calculated data and raw data can then be exported.

The following parameters are calculated and shown on the apparatus display after the movement:

- Max. Jump height
- Average speed
- Average acceleration
- Force only with additional weight and totalled with body weight
- Power only with additional weight and totalled with body weight



[29] See Federal Office of Sport BASPO, Swiss Federal Institute of Sport Magglingen SFISM and Competitive Sports Department, 2016

5. Annex

Calculated parameters

Isometric measurement:

- Maximum force
  Maximum force value in the force-time curve

- Explosive force (rate of force development, RFD)
  RFD = Δf / Δt

- Force surge
  $KS_{150} = \int_0^{150} (t)t$
  $f(t)$= Force-time curve equation

  In a geometric representation, the force impact corresponds to the area under the force-time curve between 0 and 150 ms.

- Starting force
  This is calculated as soon as an increase in force is reached after an initial force threshold (15 N) has been exceeded for a period of 20 ms.

- Dynamic strength index DSI
  It is made up of the quotient of the maximum force (Fmax) and the time (tmax) required to reach the maximum force.

  $SKI = Kmax/Tmax$ $Kmax$ = Maximum force, $Tmax$ = Time until $Kmax$ is reached.

Jump analysis

- Starting point – blue line
  The starting point of the calculation is the blue line

- Starting speed v_0
  The speed at the blue line (calculation between blue and white ds/dt) v_0 =*(Pos_blue - Pos_white) / (t_blue - t_white)*

- Jump height h
  Difference between shoulder point (red) or max. value (green) and starting point (blue)
  h = Pos_red - Pos_blue
  h = Pos_green - Pos_blue

- Average speed v_{mean}
  Speed between red and blue or green and blue (with blue v_0 applied)
  v_{mean} *= (Pos_red – Pos_blue) / (t_red - t_blue)*
  v_{mean} *= (Pos_green – Pos_blue) / (t_green-t_blue)*

- Average acceleration a_{mean}
  Speed between red and blue or green and blue (with blue V_0 applied)
  $a_{mean} = (Vred - Vblue) / (t\_red - t\_blue)$
  $a_{mean} = (Vgreen - Vblue) / (t\_green - t\_blue)$

- $F_{mean\ load}$
  Only calculated with additional weight
  $F_{mean\_load\_red} = Load[kg] * (9.81 + a_{mean\_red})$
  $F_{mean\_load\_green} = Load[kg] * (9.81 + a_{mean\_green})$

- $F_{mean\ sum}$
  Calculated with body weight and additional weight
  $F_{mean\_sum\_red} = (Load[kg] + Athlete's\ weight) * (9.81 + a_{mean\_red})$
  $F_{mean\_sum\_green} = (Load[kg] + Athlete's\ weight) * (9.81 + a_{mean\_green})$

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